glass types of particular high transmission. The Schmidt-Pechan prisms of the Leica Ultravid are coated with a dielectric mirror of high reflectivity (section 5.2.5), while the Zeiss Victory employs Abbe-König prisms which exclusively employ total internal reflections (section 5.2.2). An application of equation (10.36) to their transmission curves yields for the Ultravid $T_{v,p} = 89.4\,\%$ (daylight) and $T_{v,s} = 86.5\,\%$ (low-light transmission), and for the Victory $T_{v,p} = 93.7\,\%$ and $T_{v,s} = 91.4\,\%$, respectively. The high transmission values of the Zeiss are clearly discernible in real life observations, especially in a direct comparison with the Leica.

Despite of the fact that the transmission curves in figure 10.15 are not flat, but raising toward higher wavelengths, the binoculars do not exhibit any obvious color bias, which implies that a constant transmission throughout the visible spectrum is not among the necessary conditions for the perception of neutral color. These facts are well known to the manufacturers of e.g. light tubes, the spectra of which are far from being flat, yet shining apparently white. Rather interesting to note is another phenomenon: Most of the experienced binocular users seem to agree upon the impression that the Ultravid is offering a superior color saturation and thus a superior color contrast. It may be speculated that the high transmission of the Leica binocular near the long-wavelength end of the spectrum may be related to that observation. This section may help adding punch to images of objects that predominantly emit in warm color tones like red, orange or brown[14]. The question then arises whether or not a particular modulation of the transmission curve would boost the color contrast of the perceived image even further, without introducing any color bias. Carefully designed transmission filters might be placed in front of the objectives to achieve such a goal (figure 10.13).

[14] The author thanks Stephen Green and Mathias Metz for insightful input to these considerations.

It has to be acknowledged that many issues regarding human color perception still remain unsolved. Theoretical models such as Berek's model of vision (which is restricted to luminosity contrasts) have not yet found their counterparts in the field of color perception. One reason for this shortcoming is the parameter space, which is of considerably higher complexity, since all possible mixtures of colors would have to be covered. Another, perhaps equally serious problem is related to significant differences between individual observers, which prevents the scientists from drawing accurate and universal conclusions from their field tests. Eventually, the combined action of three color sensors (cones), with partially overlapping spectral responses, and the subsequent data processing inside the visual cortex, with emergent phenomena such as the simultaneous color contrast (section 9.2), are the root of the difficulties in arriving at a quantitative understanding of human color perception.

10.8 Depth of field

The perceived depth of field of a binocular (or telescope) is determined by both the depth measure of its optics (section 4.3) and the accommodation width of the observer (section 8.4): The former determines the virtual distance, onto which the eye has to accommodate in order to get the image into focus, and the latter decides whether such an accommodation is possible. Considering a binocular that is focused on infinity, and an observer with perfect long distance vision (or, alternately, with her spectacles on), then the minimum distance of an object that can still be accommodated amounts to

$$E_{\min} = \frac{m^2}{\delta_{\text{acc}}} \,. \tag{10.37}$$

We remind that m is the magnification of the instrument, m^2 the corresponding depth measure, and δ_{acc} stands for the accommodation width, being the